DECEMBER 2018 Update

Carrier Unlicensed Forecast

Major changes to the forecast this half include:

1. While the LAA adoption continues to expand as operators look to improve spectral efficiency and improve user experience, Wi-Fi remains a major part of operator infrastructure plans at major public venues like railcars, coffee shops, etc. where Wi-Fi remains a cost-effective, global standard. Wi-Fi 6 or 802.11ax trials in developed markets like Korea will expand to other markets as smartphone adoption increases in 2020 and beyond. While residential CPE category will drive the bulk of carrier adoption, standalone AP adoption in outdoor and indoor settings will continue as replacement of older 802.11 AP's.

2. While the enterprise Wi-Fi segment continues to grow from $5.6B in 2017 to $7.5B in 2023, the Carrier spend in the Wi-Fi infrastructure, outside of the CPE category, is expected to gradually decline over the forecast period from about $700M in 2017 to less than $400M in 2023 as operators increasingly leverage 3GPP-based technology (LTE and 5G) in the unlicensed spectrum. It should be carefully noted however that carriers will continue to invest in Wi-Fi especially in residential segment via broadband and video CPE gateways.

3. Traditional mobile carriers are predominantly focusing on LAA and CBRS for mobile offload especially in North America. Improved user experience through LAA and capacity expansion via CBRS offer incremental network capacity pathway for the operators seeking to increase network capacity and user throughput increase as they transition towards "5G" services. AT&T's "5G Evolution" marketing campaign is an example of this effort to leverage LAA to expand network capacity as they migrate towards 5G.

4. While the CBRS progress had been somewhat delayed from original enthusiasm last year, it has made significant strides in the second half of 2018. NTIA has completed a certification testing of ESC in December laying the foundation for commercial launch in 2019. Initial Commercial Deployment plans indicate broad interests from diverse applications including fixed wireless, mobile offload and private LTE use cases. The commercial ramps in 2019 will likely expand more broadly in 2020 as PAL auction entrenches broader utilization of CBRS among multiple stakeholders.

5. MulteFire focus towards "private LTE" and industrial IoT applications, in concert with Release 1.1 specification will likely prompt enterprise and OTT/neutral host interests in the second half of 2019. MulteFire Release 1.1 focus on the additional spectrum bands including 1.9 GHz for the unlicensed part of band 39 (the sXGP ecosystem in Japan), eMTC in the 2.4 GHz band, and NB-IoT in the 800/900 MHz unlicensed band will likely expand market

opportunities in Japan and Europe. The Release 1.1 specification will be publicly available in mid-2019.

6. Direct carrier investments for Wi-Fi vs. LTE-based access infrastructure is expected to reach parity in 2019-2020 as carriers increasingly adopt LTE-based technologies in the unlicensed bands through CBRS, LAA, and MulteFire. The Carrier Wi-Fi business segment is expected to cut in half from about $600M in 2018 to over $300M in 2023. Meanwhile, the carrier investment in unlicensed LTE technologies including LAA, CBRS, and MulteFire is expected to rise from over $300M in 2018 to over $1.2B in 2023.

7. We estimate that Cisco continues to lead the Carrier Wi-Fi segment in 2018 despite a slight loss in market share. The company continues to lead the overall Wi-Fi market with its dominant market position. We observe that it has largely maintained its pricing power over the past year. In the overall Wi-Fi market, Ubiquiti and other aggressive challengers are gaining share largely through price-competitive solutions as the market transitions to Wi-Fi 6 or 802.11ax.